Digital Elevation Models of Chesapeake Bay: Procedures, Data Sources, and Analysis

Prepared for the Consumer Option for an Alternative System to Allocate Losses (COASTAL) Act by the NOAA National Centers for Environmental Information (NCEI)
September 30, 2019
Love, M.R., C.J. Amante, and K.S. Carignan

Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado, Boulder, CO
NOAA National Centers for Environmental Information, Boulder, CO

Summary

In September of 2019, NOAA's National Centers for Environmental Information (NCEI) developed integrated bathymetric–topographic digital elevation models (DEMs) according to specifications developed jointly by NOAA NCEI and the United States Geological Survey (USGS) to help better define a consistent elevation mapping framework for the nation (Table 1). Overall, 97 tiled DEMs were created in the area of interest: 87 tiles were created at the highest resolution of 1/9 arc-second, 10 were created at a resolution of 1/3 arc-second. Only 1/9 arc-second DEM tiles integrate topography and bathymetry. The DEM tiles represent best publicly-available data at the time of their creation; the intent is to update specific tiles as new source data becomes available. The utilization of a tiling scheme in developing the DEMs is intended to improve data management during source data processing as well as facilitate targeted DEM updates.

The tiled DEMs cover the Chesapeake Bay including portions of the states of Maryland, Virginia, North Carolina, and Washington D.C. The extents of these DEMs, procedures, data sources, and analysis are described below. The methodologies used by NCEI in developing DEMs are described in the NOAA National Centers for Environmental Information Topo-Bathymetric Digital Elevation Models: East Florida (Amante, 2018).

Table 1. Specifications for the DEM tiles.

Grid Area	*Chesapeake Bay*
Coverage Area	77.50° to 74.75° W, 36.50° to 40.00° N
Coordinate System	Geographic decimal degrees
Horizontal Datum	NAD 83
Vertical Datum	NAVD 88
Vertical Units	Meters
Cell Size	Variable (1/9th or 1/3rd Arc-Second)
Grid Format	Geotiff

DEM Specifications

The Chesapeake Bay tiled DEMs were built to the specifications listed in Table 1. Figure 1 shows the 1/9 arc-second DEM tile boundaries in orange and the 1/3 arc-second DEM tile boundaries in green.

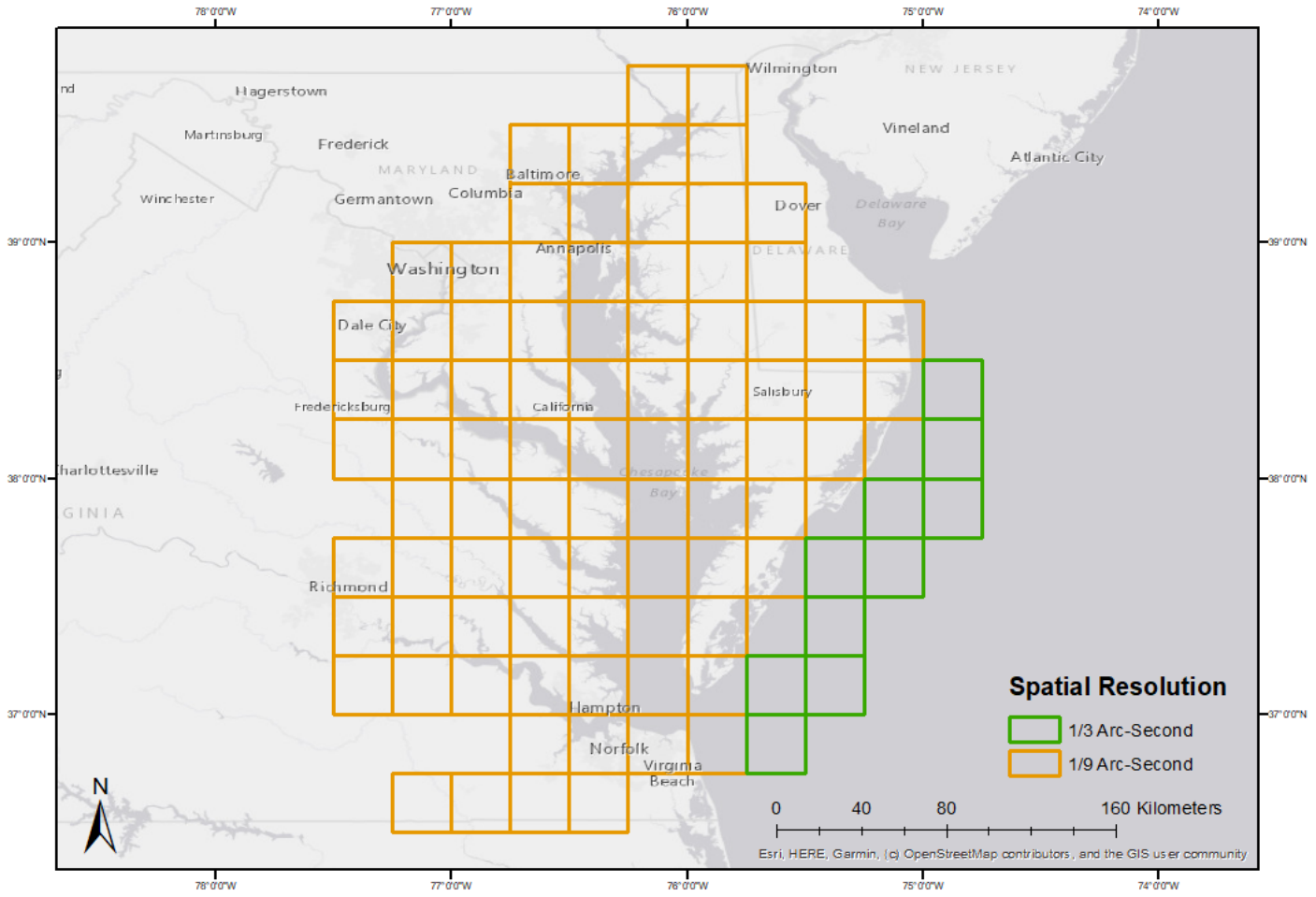

Figure 1. Map image of the DEM tile boundaries for the Chesapeake Bay DEMs.

Data Sources and Processing

Bathymetry data used in the generation of the Chesapeake Bay DEMs included NCEI Bathymetric DEM, NOAA National Ocean Service (NOS) hydrographic surveys and bathymetric attributed grids (BAGs), NOAA Office of Coast Survey (OCS) Electronic Navigational Chart (ENC) soundings, NCEI multibeam survey data, and U.S. Army Corps of Engineers (USACE) channel condition surveys (Table 2).

Table 2: Bathymetric data sources used in DEM development.

Source	*Date*	*Data Type*	*Spatial Resolution*	*Horizontal Datum*	*Vertical Datum*
NCEI Chesapeake Bay (M130) Bathymetric Model	2016	Bathymetric DEM	3 arc-seconds	WGS 84 geographic	Mean Lower Low Water (MLLW)
NOAA NOS	1876 to 2017	Hydrographic survey soundings	< 10 meters to several kilometers	NAD 83 geographic	MLLW
NOAA OCS	1934 to 2017	Extracted chart soundings	~50 meters to several kilometers	NAD 83 geographic	MLLW
NCEI	2001 to 2018	Multibeam Bathymetric Surveys	~1 to 10 meters	NAD 83 geographic	Assumed Instantaneous Water Level
NOAA NOS BAG	2006 to 2016	Hydrographic survey soundings	0.5 to 30 meters	NAD 83 geographic	MLLW
USACE	2011 to 2018	Hydrographic channel condition surveys	~1 to 10 meters	Virginia, Maryland or Delaware State Plane	MLLW

Bathymetric data were transformed to NAD 83 and NAVD88 as needed and where more recent, higher resolution data existed, older data were edited or superseded. Vertical datum transformations were performed using NOAA's VDatum Software.

Bathymetric-topographic data used in developing the Chesapeake Bay DEMs included bathymetric-topographic lidar from NOAA National Geodetic Survey (NGS), USGS and USACE (Table 3).

Table 3: Bathymetric-Topographic data sources used in DEM development.

Source	*Date*	*Data Type*	*Spatial Resolution*	*Horizontal Datum*	*Vertical Datum*
NOAA NGS Topobathy Lidar: Post Sandy (SC to NY)	2014	Bathymetric-Topographic Lidar	Variable	NAD 83 geographic	NAVD88
USACE NCMP Topobathy Lidar: East Coast	2017	Bathymetric-Topographic Lidar	Variable	NAD 83 geographic	NAVD88
USACE Post-Matthew Topobathy Lidar: Southeast	2016	Bathymetric-Topographic Lidar	Variable	NAD 83 geographic	NAVD88

Coast (VA, NC, SC, GA, FL)					
NOAA NGS Topobathy Lidar: Potomac River, Chesapeake Bay	2018	Bathymetric-Topographic Lidar	Variable	NAD 83 geographic	NAVD88
USGS Assateague Island Lidar	2016	Bathymetric-Topographic lidar-based DEM	1 meter	UTM Zone 18N	NAVD88

Topographic data used in developing the Chesapeake Bay DEMs included gridded topographic data from NCEI the Office of Coastal Management (OCM) and USGS (Table 4).

Table 4: Topographic data sources used in DEM development.

Source	***Date***	***Data Type***	***Spatial Resolution***	***Horizontal Datum***	***Vertical Datum***
NOAA OCM Coastal Inundation Digital Elevation Model: Aggregate Record	2016	DEM	1/9 arc-seconds	NAD 83 geographic	NAVD88
USGS National Elevation Model	2006	DEM	1/9 arc-seconds	WGS 84 geographic	NAVD88
USGS National Elevation Model	2006	DEM	1/3 arc-seconds	WGS 84 geographic	NAVD88

DEM Development

Development of the Chesapeake Bay DEMs followed procedures documented in NOAA National Centers for Environmental Information Topo-Bathymetric Digital Elevation Models: East Florida (Amante, 2018). Exceptions being that the bathymetric pre-surface was generated at 1/3 arc-second due to the coarse resolution of bathymetric data, and gridding weights were modified as shown in Table 5. Also, the bathymetric pre-surface derived from sources in Tables 2 and 3 was converted to XYZ and was the only bathymetric data utilized in the final DEM creation with MB-System's 'mbgrid.'

Table 5: Data hierarchy used to assign gridding weight in MB-System.

Dataset	*Relative Gridding Weight*
NOAA OCM Coastal Inundation Digital Elevation Model	20
NOAA NGS Topobathy Lidar: Post Sandy (SC to NY)	10
USACE Post-Matthew Topobathy Lidar: Southeast Coast	10
USACE NCMP Topobathy Lidar: East Coast	10
NOAA NGS Topobathy Lidar: Potomac River, Chesapeake Bay	10
USGS Assateague Island Lidar	10
USGS NED 1/9	1
USGS NED 1/3	1
Bathymetric pre-surface	1

DEM Analysis

Once the Chesapeake Bay DEMs were generated, the DEMs were compared to the high-resolution source elevation data and high-resolution imagery. Inconsistencies were evaluated and resolved based on the most reliable data available. The largest outstanding issue with the DEM tiles is the lack of publicly-available elevation data for the Aberdeen Proving Grounds in Maryland and high-resolution inland bathymetry data. In such areas, older, coarser-resolution, topographic or bathymetric data from USGS and NOAA were used. When higher resolution publicly available data becomes available for these areas, these DEM tiles will be updated with more accurate, detailed elevation information.

Reference

C.J. Amante (2018) NOAA National Centers for Environmental Information Topo-Bathymetric Digital Elevation Models: East Florida, NOAA, pp. 6.